**Worksheet 11**

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Course: COMP 47160

Q7. *Create a hash map using an array of size 13, the separate chaining collision*

*handling strategy and the following hash function:*

*h(k) = (k + 5) % 13*

\*Note: Values corresponding to keys are not shown due to question specification.

h(k) = (k + 5) % 13

1. Store entry: (Key = 353, Value =‘Ireland’)

h(k) = (353 + 5) % 13 = 7

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  |  |  |  |

2. Store entry: (Key = 44, Value = United Kingdom)

h(k) = (44 + 5) % 13 = 10

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  | 44 |  |  |

3. Store entry: (Key = 33, Value = France)

h(k) = (33 + 5) % 13 = 12

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  | 44 |  | 33 |

4. Store entry: (Key = 1, Value = United States of America)

h(k) = (1 + 5) % 13 = 6

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  | 1 | 353 |  |  | 44 |  | 33 |

5. Store entry: (Key = 49, Value = Germany)

h(k) = (49 + 5) % 13 = 2

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 |  |  | 44 |  | 33 |

6. Store entry: (Key = 679, Value = Fiji)

h(k) = (679 + 5) % 13 = 8

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 | 679 |  | 44 |  | 33 |

7. Store entry: (Key = 253, Value = Dijibouti)

h(k) = (253 + 5) % 13 = 11

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

8. Store entry: (Key = 269, Value = Comoros)

h(k) = (269 + 5) % 13 = 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  | 269 | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

9. Store entry: (Key = 61, Value = Christmas Island)

h(k) = (61 + 5) % 13 = 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  | 269  61 | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

10. Store entry: (Key = 86, Value = China)

h(k) = (86 + 5) % 13 = 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 86 | 269  61 | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

Q8. *Create a hash map using an array of size 13, the linear probing collision handling*

*strategy and the following hash function:*

*h(k) = (k + 5) % 13*

h(k) = (k + 5) % 13

1. 1. Store entry: (Key = 353, Value =‘Ireland’)

h(k) = (353 + 5) % 13 = 7

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  |  |  |  |

2. Store entry: (Key = 44, Value = United Kingdom)

h(k) = (44 + 5) % 13 = 10

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  | 44 |  |  |

3. Store entry: (Key = 33, Value = France)

h(k) = (33 + 5) % 13 = 12

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  | 44 |  | 33 |

4. Store entry: (Key = 1, Value = United States of America)

h(k) = (1 + 5) % 13 = 6

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  | 1 | 353 |  |  | 44 |  | 33 |

5. Store entry: (Key = 49, Value = Germany)

h(k) = (49 + 5) % 13 = 2

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 |  |  | 44 |  | 33 |

6. Store entry: (Key = 679, Value = Fiji)

h(k) = (679 + 5) % 13 = 8

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 | 679 |  | 44 |  | 33 |

7. Store entry: (Key = 253, Value = Dijibouti)

h(k) = (253 + 5) % 13 = 11

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

8. Store entry: (Key = 269, Value = Comoros)

h(k) = (269 + 5) % 13 = 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  | 269 | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

9. Store entry: (Key = 61, Value = Christmas Island)

h(k) = (61 + 5) % 13 = 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  | 269 | 49 | 61 |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

10. Store entry: (Key = 86, Value = China)

h(k) = (86 + 5) % 13 = 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 86 | 269 | 49 | 61 |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

Q9*. Create a hash map using an array of size 13, the double hashing collision handling*

*strategy and the following hash functions:*

*h(k) = (k + 5) % 13*

*d(k) = 5 – k % 5*

h(k) = (k + 5) % 13

d(k) = 5 – (k % 5)

1. Store entry: (Key = 353, Value =‘Ireland’)

h(k) = (353 + 5) % 13 = 7

[d(k) = 5 – (353 % 5) = 2]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  |  |  |  |

2. Store entry: (Key = 44, Value = United Kingdom)

h(k)= (44 + 5) % 13 = 10

[d(k) = 5 – (44 % 5) = 1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  | 44 |  |  |

3. Store entry: (Key = 33, Value = France)

h(k) = (33 + 5) % 13 = 12

[d(k) = 5 – (33 % 5) = 2]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  |  | 353 |  |  | 44 |  | 33 |

4. Store entry: (Key = 1, Value = United States of America)

h(k) = (1 + 5) % 13 = 6

[d(k) = 5 – (1 % 5) = 4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  |  |  |  |  | 1 | 353 |  |  | 44 |  | 33 |

5. Store entry: (Key = 49, Value = Germany)

h(k) = (49 + 5) % 13 = 2

[d(k) = 5 – (49 % 5) = 1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 |  |  | 44 |  | 33 |

6. Store entry: (Key = 679, Value = Fiji)

h(k) = (679 + 5) % 13 = 8

[d(k) = 5 – (679 % 5) = 1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 | 679 |  | 44 |  | 33 |

7. Store entry: (Key = 253, Value = Dijibouti)

h(k) = (253 + 5) % 13 = 11

[d(k) = 5 – (253 % 5) = 2]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  |  | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

8. Store entry: (Key = 269, Value = Comoros)

h(k) = (269 + 5) % 13 = 1

[d(k) = 5 – (269 % 5) = 1]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  | 269 | 49 |  |  |  | 1 | 353 | 679 |  | 44 | 253 | 33 |

9. Store entry: (Key = 61, Value = Christmas Island)

h(k) = (61 + 5) % 13 = 1

d(k) = 5 – (61 % 5) = 4

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|  | 269 | 49 |  |  | 61 | 1 | 353 | 679 |  | 44 | 253 | 33 |

10. Store entry: (Key = 86, Value = China)

h(k) = (86 + 5) % 13 = 0

[d(k) = 5 - (86 % 5) = 4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
| 86 | 269 | 49 |  |  | 61 | 1 | 353 | 679 |  | 44 | 253 | 33 |